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Assessment of the Scotian Shelf silver hake population to 2003

Évaluation de la population du merlu argenté du plateau néo-écossais d'après les données jusqu'à 2003

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Abstract

The last complete assessment of Scotian Shelf silver hake was conducted in 1999 and included data to 1998. This assessment includes new information from the commercial fishery and research cruises, from 1999 to 2003. Attributes of stock status are generally poor. Survey estimates of abundance and biomass remain very low and total mortality is high. Growth at present is poor, with condition and length-at-age below long-term averages. Changes in maturation have occurred, with fish maturing at shorter length and a higher proportion maturing at age 1 and 2. The 2002 year class is thought to be very large. However, because of high total mortality and reduced growth, this year class may not result in a significant increase in the spawning stock biomass. Changes have been seen in the catch at age of the commercial fishery, and age 1 fish are now an important component of the catch. This exploitation pattern of the Scotian Shelf silver hake fishery may be unsustainable and efforts should be made to reduce the proportion of age 1 fish in the catch, though gear modifications or area closures.

Résumé

La dernière évaluation complète du merlu argenté du plateau néo-écossais a été réalisée en 1999 et comprenait des données d'années antérieures (jusqu'à 1998). La présente évaluation comprend de nouvelles données sur la pêche commerciale et les relevés effectués entre 1999 et 2003. En général, les caractéristiques de l'état du stock sont mauvaises. Les estimations de l'abondance et de la biomasse effectuées lors des relevés demeurent très faibles, et la mortalité totale est élevée. À l'heure actuelle, la croissance est mauvaise puisque la condition et la longueur selon l'âge sont inférieures aux moyennes à long terme. Des changements se sont produits sur le plan de la maturation : la longueur à maturation a diminué et une plus grande proportion des poissons atteignent la maturité à un ou deux ans. La classe d'âge de 2002 serait très abondante. Cependant, en raison du haut taux de mortalité et de la croissance réduite, cette classe d'âge pourrait ne pas donner lieu à une augmentation importante de la biomasse des géniteurs. Des changements ont été observés dans les captures commerciales par âge, et les poissons d'un an constituent maintenant une part importante des captures. Ce régime d'exploitation du merlu argenté du plateau néo-écossais pourrait être non durable, et des efforts devraient être menés pour réduire la proportion de poissons d'un an capturés (par l'intermédiaire de modifications aux engins ou de la fermeture de certaines zones).

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The Fishery

The silver hake fishery has been conducted on the Scotian Shelf (NAFO Div. 4VWX, Fig. 1) since the mid-1960's, primarily by the distant water fleets of Russia, Cuba and Japan in the early years. Prior to 1977, fishing on the Scotian Shelf was unrestricted in terms of area, mesh size and season. During this period fishing was conducted over the entire shelf, and the use of trawl mesh as small as 40 mm was common. Following the extension of jurisdiction to 200 miles by coastal states in 1977, Canada implemented the Coastal Fisheries Protection Act, which restricted fishing for this species to the seaward side of the Small Mesh Gear Line (SMGL, Fig 2), west of 60° W longitude, with a minimum mesh size of 60 mm. On an experimental basis, a portion (4-6 vessels) of the fleet was allowed to fish landward of the SMGL during 1978 and 1979. From 1980 through 1983, fishing was permitted by condition of license in an eastern extension of the Silver Hake Box as far as 57° W longitude; from 1984 to present this eastern extension has been restricted to 59° W longitude. In 1994 further restrictions were introduced to minimize incidental catches of cod, haddock and pollock in the silver hake fishery. These included a repositioning of the SMGL to prevent fishing in depths less than 190 m (Branton, 1998) and the use of a separator grate with 40 mm bar spacing in the lengthening piece of the trawl.

Canadian fishing interests have engaged in experimental harvesting of this species since 1975, although until 1995 these efforts were developmental in nature (Showell and Cooper, MS1997). From 1995 to present a commercial fishery has been conducted by the Canadian tonnage class 3 (< 65') mobile gear fleet in and around Emerald and LaHave basins (Fig. 2). Concern was expressed over the harvesting of small fish in these inshore areas, and experimental evidence suggested a change to 55 mm square mesh would be effective in releasing small silver hake (Cooper, 1995). As a result 55 mm square mesh, rather than the traditional 60 mm diamond, was made mandatory in 1999. Initially a topside chafer was required to support the codend during haulback, as the tensile strength of the twine used to manufacture the square mesh was lower than that of traditional diamond mesh. It was recognized that gear configured in this manner had the potential to block the meshes, thus mitigating the benefits of the square mesh. To address this, a codend composed of stronger twine was designed, and from 2000 onwards topside chaffers have not been used in this fishery.

Nominal catches from this stock range from nearly 300,000 tons in 1973 to under 8,000 tons in 1994 (Table 1). Catches by the foreign fleet were generally high during the mid to late 1980's, with catches in recent years much lower (Table 1, Fig. 3). As the inshore Canadian fishery has developed, proportions of the catch harvested by the inshore (Basin) and offshore (Slope) fleet components have changed, and since 1998 the catch by the inshore fleet has exceeded that of the offshore (Fig. 4).

Recent Total Allowable Catches (TAC's) and landed catches ('000 tons) are as follows:

Year[1]	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TAC	105	86	30	50	60	50	55	33	20	20	20	15
Catch	32	29	8	18	26	17	16	17	13	18	17	

[1] Landings and TAC in 1999 refer to the 15 month period from January 1, 1999 to March 31, 2000. From 2000 onwards, landings and TAC refer to the period from April 1 of the current year to March 31 of the following year.

Removals at Age & Size and Weights-at-Age

While no foreign allocations of silver hake have been made since 1997, the fishery is conducted by two distinct fleets - Canadian flag vessels < 65' fishing in or near to Emerald and LaHave Basins, and Cuban flagged tonnage class 7 vessels fishing seaward of the SMGL line under charter arrangements with Canadian partners. Several changes to the SMGL, and numerous temporary exemptions have occurred since 1994 to accommodate the Cuban fleet in this area. Details of these changes are can be found in Branton, 1998.

Sampling for length composition and aging material from foreign vessels in 1999-2002 was conducted by Canadian observers, with 100% of the fishery covered. Landings by the Canadian <65' fleet are sampled routinely by DFO and Industry shore samplers. The commercial removals at age were calculated using the standard Marine Fish Division Catch-at-Age application, unculled length frequency data and quarterly age/length keys, by sex. Regressions of lengths with weights from the Canadian July research vessel survey were used to calculate yearly alphas and betas by sex (Table 2) used in the calculation of length frequency based commercial sample weights and commercial mean weight-at-age. In one case, first quarter catches were added to that of the second quarter as the catch was small and sampling was limited (Table 3). Results are presented in Table 4.

The age groups on which the fishery are conducted have changed over time. Until the late 1980's, most of the catch was age 3 and 4 fish. From 1990 to 1998, the catch shifted to age 2 and 3 year olds, and in 1999 and 2000 the majority of the catch was age 1 (Fig. 5). Since 1999, most of the catch of 1 year old fish have been taken by the Canadian fleet (Fig. 6) fishing in Emerald and LaHave Basins.

Using maturity at age from research vessel surveys, the proportion of the total commercial catch that is immature can be estimated. From 1978-1998 the proportion of immature fish in the commercial catch was around 5-10%. However, this increased dramatically to 40% in 1999 and 2000, and remained high in 2001 and 2002 (Fig. 7).

The removals at age for 1977-99 were taken from the previous assessment (Showell and Fanning, 1999) to provide estimates for the period 1977-2002 inclusive (Table 5).

Commercial mean weight-at-age was calculated for the same periods as the catch-at-age for each fleet, weighted by monthly catches. An aggregate mean weight-at-age was than calculated, weighting by the catches of each fleet (Table 6). As has been noted in the past for this stock, commercial mean weight-at-age declined from 1977 to 1994, but has stayed relatively stable at a lower level in subsequent years (Fig. 8).

Research Vessel Surveys

The July stratified random design groundfish research vessel (RV) survey has been conducted on the Scotian Shelf (Fig. 9) from 1970 using three Canadian research vessels (A.T. Cameron, Lady Hammond, and the Alfred Needler). Based on an analysis of comparative fishing experiments by Fanning (1985) a conversion factor of 2.3 is applied to the abundance series prior to 1982 to account for the effect of vessel and gear changes between the A.T. Cameron and the other two vessels. The same conversion factor was used to adjust biomass estimates. No conversion factor is required between the Lady Hammond and the Alfred Needler.

Silver hake found in the Bay of Fundy area likely represent a portion of the Gulf of Maine/N. Georges Bank silver hake stock, rather than the Scotian Shelf stock (Showell, 1998). As was the case in the previous assessment of this resource, survey trends in both total numbers and biomass were therefore calculated for the Scotian Shelf portion of 4VWX only, excluding strata 484 through 495 (Fig. 9).

Survey trends in both numbers and biomass show relatively high abundance in the early to mid-80's, followed by a decline to relatively low levels over the period 1988-94 (Fig. 10, Table 7). Abundance and biomass increased in 1995 and 1996, but has subsequently declined to low levels – similar to that seen in 1991-92. In 2003, total abundance increased sharply, while biomass only showed a slight increase. This suggests the 2002 year-class may be abundant.

Numbers-at-age for the Scotian Shelf strata only are presented in Table 8. As estimated by the 2002 survey, all year classes are below average in abundance.

Industry Survey

A standardized groundfish survey has been conducted in 4X by the Individual Transferable Quota (ITQ) mobile gear < 65' fleet since 1995, with sampling since 1996 considered appropriate for abundance estimates. While this survey does not cover the entire stock area for silver hake it does cover areas in 4X that are not accessible to the DFO summer RV survey, and can provide an additional useful index of abundance, despite the relatively small number of years for which it's been conducted. The survey shows a declining trend in both numbers and biomass since 1999. As was the case for the RV survey, in 2003 number per tow estimates increased sharply, while biomass only increased slightly. (Table 9, Fig.11), suggesting the 2002 yearclass may be abundant. A comparison of ITQ numbers per tow (strata 484-495 excluded) to the July RV total numbers is presented in Fig. 11.

Commercial Catch Rates

Analyses of deviance using a generalised linear modelling approach with S-Plus 6.1 were conducted to determine magnitudes of influence of year, month and area on commercial catch rates of Canadian silver hake fishers, expressed as subtrip tons per fishing days, and to compute predicted catch rates on an annual basis. Preliminary studies were used to examine an extension to the area scheme distinguishing slope and basin fishery locations. NAFO areas were found to mostly subsume any potential for slope/basin effects, so the NAFO zones were retained as the only area factor. After these preliminary studies, the data was restricted to NAFO unit areas 4Whkl4Xmn, the dominant locales of the fishery, and to boats with at least five years experience in the fishery. This latter restriction, intended to reduce the potential for the learning curves of more recent entrants to the fishery to confuse results, this left 15 of the 54 Canadian boats known to prosecute this fishery. These 15 boats were considered index fishers.

These 15 index fishers were themselves included as factors in the base model. This explicitly quantifies the intrinsic differences in catch rates between individual boats, this component of the variance being accounted for before attributing variance to other factors (year, month, area). Variable sequencing among year, month and area in models was determined by comparing Akaike Information Criteria (AIC) for different models, which uses $\chi 2$ tests to determine the best fit from a set of possible models. The relative ranking of a given factor, in terms of explanatory power, is estimated by inclusion in and exclusion from iterative series of possible models, with calculation of AIC statistics, to achieve the likeliest hierarchy of main effects for the model. Two-way interactions are then sequenced according to the main effects (i.e. if the main effects were ordered year, month, area then the interaction terms would be year:month, year:area, month:area).

Annual predictions for month/area combinations most representative of the fishery were reviewed, and it was determined that interaction effects in the model were minor differences of degree, with commonality in trends being apparent. It was also decided that the unit areas within each of 4W and 4X could be combined, for a final two-area model, from which an annual predicted catch rate series for the fishery in 4W during July was selected as a reasonable index of catch rate trends for the fishery as a whole (Table 10, Fig. 13). A declining trend is evident since 1997. As a comparison, the CPUE series is plotted with the summer RV mean kg/tow series, and some correspondence is clear (Fig. 14).

Relative F

Relative fishing mortality can be calculated as the ratio of the commercial catch over the stratified total biomass estimates from the July RV survey (Fig. 15). This statistic does not give an absolute estimate of the true fishing mortality, but trends over time can be useful in examining exploitation patterns. Relative F was extremely high in the 1970's and high from 1988 to 1991. For the past decade relative F has been low, but has shown an increasing trend since 2000.

Recruiting Year-class Sizes

Estimates of age 1 abundance are available from the July RV survey (Table 8). For the most recent year aging is not complete, but an approximation of the 2002 year-class at age 1 can be made based on abundance of fish <23 cm (Branton *et al.*, 1997). Recruitment in recent years has been variable. The 1998 and 1999 year-classes were above average in abundance, but that of 2000 and 2001 below average. The 2002 year-class is very strong, at more than twice the average and is the largest seen since 1985. (Fig. 16)

Estimates of Total Mortality (Z)

The mean numbers per tow index from the July survey was used to calculate total mortality. To reduce variability in the estimates, the results were grouped into age classes (2-4, 6-8) and smoothed using a three year moving average (Fig. 17). Based on this method, total mortality on age 2-4 fish (ie the age classes on which the fishery traditionally has been conducted) has remained relatively high, despite a sharp decline in catches. In recent years total mortality for the oldest ages has been low relative to that of age 2-4, likely as a result of gear changes which required use of a grate from 1994 onwards.

Biological Indices

Previous analysis (Showell, 1997b) has shown both condition (weight for given length, Fig. 18) and mean length-at-age (Table 11a&b, Fig. 19) to have declined from 1971 to 1995, with the two factors combining to produce very low mean weights-at-age relative to the early period in the time series (Table 12a&b, Fig. 20). Since the mid-1990's condition and length-at-age have stabilized at this lower level.

Maturity observations have been routinely collected for this species on the July RV survey. The survey immediately precedes the spawning period for silver hake, and this timing allows accurate distinction between mature and immature fish. Length of 50% maturity has declined over the time series (Fig. 21), with females declining from about 27 cm in the 1971 to 1981 period, to approximately 23 cm from 1991 to present. Males show similar trends, with length of 50% maturity generally greater than 23 cm from 1971 to 1980, compared to 19 or 20 cm in recent years. Changes of this nature have been attributed to a population undergoing stress (Trippel, 1995). Given the early maturation of silver hake, significant declines in length of maturity for this species may approach a physiological limit for spawning. Trends are also seen in the maturity-at-age observations from the July RV survey, with the proportion of mature females at age 1 and 2 increasing since 1982 (Fig. 22).

In recent years attempts have been made to qualify survey abundance estimates for many stocks with indices of spatial distribution. Two such indices were applied to silver hake for this assessment. One, the proportion of the historical stock area encompassing 75% of the annual estimated survey biomass, serves as a measure of resource concentration. A second index, the proportion of annual survey sets where the species occurs (non-zero sets), is a measure of the area occupied by the species. While both these indices declined sharply in 1980 and again in 1992 (Fig. 23), currently they are stable at a high level, indicating that the resource is widely distributed throughout it's range.

Outlook

This stock continues to be in poor condition.

Survey biomass remains very low and total mortality is high. Growth at present is poor, with condition and length-at-age below long-term averages. Changes in maturation have occurred, with fish maturing at shorter length and a higher proportion maturing at age 1 and 2.

The 2002 year class is thought to be very large. However, because of the high total mortality and reduced growth, this year class is not expected to result in a significant increase in the spawning stock biomass.

Changes have been seen in the catch-at-age of the commercial fishery, with age 1 fish now making up an important component of the catch. Helser et al. (1996) investigated the implications of harvesting such a high proportion of age 1 silver hake in US stocks. The conclusion from this work was that a fishery with a 50%-at-age-1 exploitation pattern could jeopardize the health of these stocks due to a decline in spawning stock biomass. The exploitation pattern of the Scotian Shelf silver hake fishery may be unsustainable and efforts should be made to reduce the proportion of age 1 fish in the catch, though gear modifications or areal closures.

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Table 1: Nominal catches (mt) for 4VWX silver hake 1970-2002.

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Bulgaria	0	0	0	0	0	1722	3088	862	606	4639	817	0	0
Canada	0	0	0	0	11	101	26	10	26	13	104	6	38
Cuba	0	0	201	0	0	1724	12572	1847	3436	1798	2287	642	11969
France	0	0	0	0	0	0	0	15	0	0	0	0	2[1]
FRG	0	0	10	0	296	106	97	684	0	0	0	0	0
GDR	0	0	0	0	0	0	0	0	3	0	0	0	0
Ireland	0	0	0	0	0	108	106	0	0	9	0	0	0
Italy	0	0	0	0	0	0	0	38	106	5	0	541	37[1]
Japan	129	8	63	88	67	54	78	19	161	219	239	120	937
Poland	0	0	0	0	0	0	0	295	2	0	0	1[1]	31[2]
Portugal	0	0	0	0	0	0	0	0	0	0	56	2044	2[1]
Romania	0	0	0	0	0	0	0	10	0	1	0	0	0
Spain	0	15	0	0	0	6	0	0	2	0	40	0	0
USA	0	1	1	1	1	7	1	14	0	0	0	3	2
USSR	168916	128633	113774	298533	95371	112566	81216	33301	44062	45076	40982	41243	47261
Total	169045	128657	114048	298621	95745	116394	97184	37095	48404	51760	44525	44600	60251

[1] Observer Program Data
[2] FLASH data
* Landings refer to the 15 month period from January 1, 1999 to March 31, 2000.
** Commencing in 2000, fishing year and landings refer to the period from April 1st of the current year to March 31st of the following year

Table 1(con't): Nominal catches (mt) for 4VWX silver hake 1970-2002.

Country	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Bulgaria	0	0	0	0	0	0	0	88	0	0	0	0	0
Canada	15	10	2	9	13	9	337	10	34	4	73	57	300[1]
Cuba	7418	14496	17683	16041	20219	9016	14541	13888	23708	16528	22018	7788	16835[1]
France	0	0	0	0	0	0	0	0	0	0	0	0	0
FRG	0	0	0	0	0	0	0	0	0	0	0	0	0
GDR	0	93	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0
Italy	2[2]	0	0	0	0	0	0	0	0	0	0	0	0
Japan	649	530	120	66	144	0	194	315	781	547	0	0	0
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	378	1714	1338	0	0	0	0	0	0	0	0	0	0
Romania	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	0	0	0	0	0	0	0	0	0	0	0
USA	0	0	0	1	0	0		0	0	0	0	0	0
USSR	27377	57423	56337	66571	41329	65349	72917	55429	40786	14716	7139[1]	0	0
Total	35839	74266	75480	82688	61705	74374	87989	69730	65309	31795	29230	7845	17835

[1] Observer Program Data
[2] FLASH data
* Landings refer to the 15 month period from January 1, 1999 to March 31, 2000.
** Commencing in 2000, fishing year and landings refer to the period from April 1st of the current year to March 31st of the following year

Table 1(con't): Nominal catches (mt) for 4VWX silver hake 1970-2002.

Country	1996	1997	1998	1999*	2000**	2001	2002
Bulgaria	0	0	0	0	0	0	0
Canada	3473	4203	9979	16700	12900	18000	16700
Cuba	2177 3[1]	11961[1]	6083[1]	0	0	0	0
France	0	0	0	0	0	0	0
FRG	0	0	0	0	0	0	0
GDR	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0
Italy	0	0	0	0	0	0	0
Japan	0	0	0	0	0	0	0
Poland	0	0	0	0	0	0	0
Portugal	0	0	0	0	0	0	0
Romania	0	0	0	0	0	0	0
Spain	0	0	0	0	0	0	0
USA	0	0	0	0	0	0	0
USSR	669	0	168	0	0	0	0
Total	25927	16,164	16062	16700	12900	18000	16700

[1] Observer Program Data
[2] FLASH data
* Landings refer to the 15 month period from January 1, 1999 to March 31, 2000.
** Commencing in 2000, fishing year and landings refer to the period from April 1st of the current year to March 31st of the following year

Table 2: Length/weight regressions: Male and female alpha and beta's from the July Research Vessel Survey of the Scotian Shelf.

Year	Male - Alpha	Female - Alpha	Male - Beta	Female - Beta
1970	0.000001153	0.000001953	3.5527	3.3849
1971	0.000004751	0.000006121	3.1382	3.0654
1972	0.000004408	0.000003823	3.1365	3.1865
1973	0.000004242	0.000004353	3.1584	3.1467
1974	0.000004817	0.000004308	3.1169	3.1479
1975	0.000013241	0.000006844	2.8346	3.0375
1976	0.000014429	0.000006401	2.7841	3.0354
1977	0.000006260	0.000006930	3.0626	3.0350
1978	0.000004630	0.000003070	3.1366	3.2531
1979	0.000010200	0.000005880	2.9001	3.0675
1980	0.000002330	0.000001800	3.3417	3.3989
1981	0.000006830	0.000005080	3.0206	3.1172
1982	0.000011600	0.000006740	2.8575	3.0232
1983	0.000006480	0.000003320	2.9935	3.2034
1984	0.000018300	0.000006490	2.7052	3.0284
1985	0.000013500	0.000004530	2.7848	3.1235
1986	0.000007970	0.000003820	2.9384	3.1685
1987	0.000009990	0.000004240	2.8798	3.1456
1988	0.000014300	0.000004800	2.7942	3.1241
1989	0.000006750	0.000004440	3.0114	3.1416
1990	0.000034320	0.000021000	2.5234	2.6958
1991	0.000007773	0.000003488	2.9582	3.2036
1992	0.000003938	0.000003157	3.1824	3.2533
1993	0.000003461	0.000003089	3.178	3.2202
1994	0.000003336	0.000003147	3.2009	3.2228
1995	0.000003340	0.000002367	3.2151	3.3233
1996	0.000002548	0.000002460	3.2909	3.3040
1997	0.000002939	0.000002479	3.2511	3.3050
1998	0.000003682	0.000003049	3.1783	3.2390
1999	0.000002822	0.000002998	3.2564	3.2392
2000	0.000003240	0.000002430	3.1958	3.2920
2001	0.000002840	0.000002230	3.2513	3.3270
2002	0.000002920	0.000002250	3.2531	3.3220

Table 3. Sampling history for Silver Hake (1999 - 2002).

Year	Quarter	Keys	# Samples	# Measured	# Aged	Catch (t)
1999	1	Domestic (Q1)	51	11684	240	974
		Foreign (Q1)	102	22044	145	1374
	Total		153	33728	385	2348
	2	Domestic (Q2)	126	26229	323	4845
		Foreign (Q2)	301	72564	296	3080
	Total		427	98793	619	7925
	3	Domestic (Q3)	40	9101	240	2336
		Foreign (Q3)	52	11381	86	383
	Total		92	20482	326	2719
	4	Domestic (Q4)	16	3377	162	3659
		Foreign (Q4)	12	2691	58	50
	Total		28	6068	220	3709
Total			700	159071	1550	16701
2000	1	Domestic (Q1)	90	19155	95	3177
		Foreign (Q1)	110	24456	89	546
	Total		200	43611	184	3723
	2	Domestic (Q2)	96	17040	114	3950
		Foreign (Q2)	71	15981	70	486
	Total		167	33021	184	4436
	3	Domestic (Q3)	87	18406	163	1560
		Foreign (Q3)	47	10185	29	216
	Total		134	28591	192	1776
	4	Domestic (Q4)	43	8534	115	2966
		Foreign (Q4)	---	---	---	---
	Total		43	8534	115	2966
Total			544	113757	675	12901
2001	1	Domestic (Q1)	52	9974	173	3886
		Foreign (Q1)	16	3474	56	126
	Total		68	13448	229	4012
	2	Domestic (Q2)	100	18584	205	5926
		Foreign (Q2)	120	25793	133	1651
	Total		220	44377	338	7577
	3	Domestic (Q3)	34	6326	123	2526
		Foreign (Q3)	17	3633	33	194
	Total		51	9959	156	2720
	4	Domestic (Q4)	39	6842	169	3691
		Foreign (Q4)	---	---	---	---
	Total		39	6842	169	3691
Total			378	74626	892	18000
2002	1	Domestic (Q1)	96	17186	200	3399
		Foreign (Q1)	---	---	---	(650 - added to Q2)
	Total		96	17186	200	3399
	2	Domestic (Q2)	53	9306	157	4074
		Foreign (Q2)	82	17035	113	2556 (1906+650)
	Total		135	26341	270	6630
	3	Domestic (Q3)	44	8149	126	3025
		Foreign (Q3)	---	---	---	---
	Total		44	8149	126	3025
	4	Domestic (Q4)	30	4760	104	3647
		Foreign (Q4)	---	---	---	---
	Total		30	4760	104	3647
Total			305	56436	700	16701

Table 4: Silver hake catch at age ('000), by fleet (1998 - 2002).

Foreign age	1999	2000	2001	2002
1	13910.1	1667.4	258.3	166.4
2	10996.8	4932.5	13444.5	9741.6
3	14177.9	3017.1	4149.0	19688.3
4	4561.8	673.3	1002.7	2414.2
5	236.8	96.4	46.6	32.4
6	38.2	1.8	22.0	6.5
7	7.4	0.7	0.0	0.6
8	0.1	0.7	0.0	0.0
9	0.0	0.0	0.0	0.0
Canadian				
1	64043.0	88911.8	50544.2	42897.4
2	33854.7	50014.3	117478.9	69554.7
3	14512.7	10774.2	17756.2	30771.1
4	4874.3	1579.4	3372.6	2134.8
5	372.4	288.6	373.6	516.9
6	138.1	29.0	99.4	127.5
7	21.7	3.6	30.1	15.6
8	0.1	0.1	8.9	0.3
9	0.0	0.0	0.1	0

Table 5: Catch-at-age ('000's) for Scotian Shelf silver hake, 1977-2002

	1	2	3	4	5	6	7	8	9
1977	17911	72529	59862	15070	2218	725	97	91	4
1978	20940	70302	80196	35025	12709	5227	1906	1168	338
1979	20569	57893	72891	36669	22380	9970	3168	495	374
1980	16588	70696	70391	32032	14465	5184	1431	451	98
1981	2358	25214	109035	37573	11928	3234	1201	290	141
1982	20189	52976	75876	68400	31752	5945	2042	465	64
1983	5849	96852	56158	29282	11388	3395	819	253	88
1984	59588	45828	206900	82911	19344	4268	1038	183	10
1985	14970	130814	98346	128365	34110	9327	2344	226	85
1986	45598	70269	229126	84097	28635	8760	1436	497	111
1987	6804	214235	114417	54211	13063	6045	347	156	117
1988	5110	62791	265307	39242	21303	3106	2133	208	143
1989	24264	85846	158745	145105	20025	9369	1569	1166	39
1990	6516	209620	142862	41215	11741	1648	640	107	40
1991	5738	117305	201243	46414	12154	3954	290	181	50
1992	7461	74491	73526	27777	3461	1247	159	33	5
1993	31572	83140	70735	35222	5511	595	71	30	3
1994	1651	13265	35250	8847	1283	150	18	8	0.1
1995	3500	35925	45615	31316	5183	457	58	41	3
1996	33501	92030	43686	23234	4928	888	148	75	0.1
1997	16132	34018	37497	25384	3579	339	29	27	2
1998	14232	44018	40311	11447	1690	235	22	4	0.1
1999	77953	44851	28690	9436	609	176	29	0.2	0
2000	90579	54947	13791	2253	385	31	4	1	0
2001	50803	130923	21905	4375	420	121	30	9	0.1
2002	43064	79296	50459	4594	549	134	16	0.3	0

Table 6: Commercial mean weight at age for Scotian Shelf Silver hake, 1977-2002.

	1	2	3	4	5	6	7	8	9
1977	0.065	0.183	0.264	0.340	0.446	0.632	0.886	0.922	2.120
1978	0.074	0.153	0.229	0.266	0.335	0.405	0.438	0.540	0.892
1979	0.076	0.178	0.227	0.274	0.304	0.389	0.455	0.838	0.838
1980	0.040	0.151	0.223	0.287	0.341	0.391	0.531	0.839	0.859
1981	0.061	0.168	0.215	0.276	0.326	0.401	0.553	0.923	1.137
1982	0.066	0.169	0.231	0.275	0.317	0.394	0.446	0.513	0.506
1983	0.067	0.128	0.196	0.239	0.289	0.365	0.395	0.457	0.444
1984	0.070	0.146	0.181	0.224	0.272	0.353	0.405	0.624	0.650
1985	0.068	0.136	0.177	0.210	0.244	0.295	0.410	0.582	0.669
1986	0.053	0.145	0.184	0.250	0.250	0.274	0.392	0.514	0.644
1987	0.045	0.119	0.168	0.211	0.248	0.286	0.453	0.422	0.518
1988	0.045	0.139	0.185	0.227	0.260	0.292	0.401	0.497	0.688
1989	0.060	0.135	0.195	0.224	0.278	0.349	0.403	0.511	0.820
1990	0.063	0.139	0.184	0.217	0.240	0.315	0.370	0.401	0.545
1991	0.047	0.139	0.189	0.215	0.263	0.314	0.471	0.511	0.568
1992	0.080	0.14	0.190	0.210	0.260	0.280	0.370	0.410	0.690
1993	0.060	0.11	0.150	0.190	0.230	0.280	0.380	0.320	0.960
1994	0.050	0.100	0.130	0.170	0.190	0.270	0.380	0.420	0.717
1995	0.060	0.100	0.140	0.170	0.210	0.310	0.410	0.440	0.620
1996	0.040	0.100	0.139	0.169	0.207	0.293	0.505	0.433	0.717
1997	0.050	0.100	0.136	0.170	0.202	0.291	0.432	0.431	0.685
1998	0.070	0.105	0.140	0.175	0.210	0.295	0.280	0.730	0.674
1999	0.067	0.096	0.137	0.165	0.230	0.321	0.347	0.567	
2000	0.060	0.095	0.129	0.165	0.237	0.338	0.283	0.495	
2001	0.063	0.086	0.127	0.159	0.223	0.282	0.445	0.419	0.759
2002	0.068	0.100	0.131	0.174	0.237	0.281	0.439	0.751	

Table 7: Scotian Shelf silver hake July RV survey total stratified numbers (x 10^{-6}) and biomass (t x 10^{-3}). Strata 484-495 excluded, 1970 to 1981 corrected for vessel effect.

year	biomass	numbers
1970	45.6	275.4
1971	14.0	81.1
1972	29.4	164.1
1973	73.1	438.5
1974	64.0	319.7
1975	13.0	65.7
1976	30.1	152.2
1977	14.6	56.5
1978	21.4	84.0
1979	69.3	329.8
1980	19.0	77.3
1981	75.9	333.3
1982	107.8	654.8
1983	33.3	214.8
1984	79.8	512.9
1985	62.8	346.1
1986	48.4	454.4
1987	56.5	469.0
1988	43.3	276.2
1989	27.3	254.2
1990	37.4	284.5
1991	26.0	178.5
1992	20.9	148.7
1993	30.2	298.1
1994	23.0	235.3
1995	42.8	324.0
1996	44.7	379.5
1997	30.9	339.0
1998	19.9	181.9
1999	16.9	220.7
2000	23.1	268.2
2001	29.1	276.4
2002	11.3	116.7
2003	17.6	292.3

Table 8: Scotian Shelf silver hake July RV survey numbers (x 10^{-6}) at age, strata 484-495 excluded. 1971 to 1981 corrected for vessel effect.

AGE	1	2	3	4	5	6	7	8	9
1971	23.5	33.2	12.1	4.1	1.9	0.3	0.0	0.3	0.0
1972	46.6	82.6	12.5	7.4	3.0	1.9	0.4	0.6	0.1
1973	128.2	237.6	15.4	13.2	12.4	6.5	2.6	1.7	0.1
1974	58.1	168.7	57.7	6.2	6.6	5.8	1.3	0.5	0.0
1975	18.9	28.3	4.8	3.8	1.5	0.9	0.3	0.4	0.0
1976	35.2	86.0	13.6	6.3	2.6	1.1	0.3	0.2	0.2
1977	4.5	22.1	18.9	4.4	1.3	1.2	0.9	0.3	0.3
1978	22.4	21.5	15.6	8.6	6.4	2.9	1.3	0.5	0.8
1979	66.9	140.0	62.8	21.3	12.0	5.4	2.6	0.9	0.3
1980	11.0	19.0	25.6	7.2	4.6	3.6	1.5	0.8	0.4
1981	30.2	81.8	116.4	59.8	18.8	6.3	2.5	0.8	0.7
1982	178.0	297.3	73.5	55.6	32.0	10.0	4.7	3.2	0.3
1983	42.0	100.3	36.8	18.0	11.1	3.3	1.4	0.5	0.3
1984	174.7	64.6	203.3	42.9	14.3	8.5	3.2	1.2	0.5
1985	38.3	177.4	36.3	61.1	21.8	6.7	2.7	1.2	0.2
1986	262.5	71.8	70.7	25.5	15.4	4.5	2.1	0.7	0.5
1987	140.1	252.2	42.4	18.4	6.9	4.6	1.4	0.8	0.5
1988	68.4	84.1	83.0	17.6	15.4	2.8	2.9	0.5	0.1
1989	128.4	60.4	22.4	13.5	3.6	1.8	0.7	0.3	0.1
1990	89.9	113.4	47.0	13.9	4.6	1.2	0.4	0.2	0.1
1991	39.6	80.8	34.1	13.5	6.7	3.0	0.5	0.1	0.1
1992	25.8	59.2	42.2	12.1	5.3	3.0	0.7	0.1	0.2
1993	112.2	90.2	65.0	26.7	2.9	0.8	0.6	0.1	0.0
1994	86.0	59.0	55.4	23.2	9.6	1.4	0.3	0.2	0.1
1995	92.7	72.7	76.4	59.5	15.7	3.7	1.6	0.6	0.7
1996	92.6	179.8	53.1	40.2	9.2	1.9	0.3	0.6	0.2
1997	142.6	122.4	53.3	6.5	3.5	0.6	0.1	0.1	0.0
1998	34.3	92.7	35.7	12.8	2.0	1.5	0.3	0.0	0.0
1999	130.7	56.0	21.0	6.1	2.0	0.3	0.1	0.0	0.0
2000	158.9	73.7	23.6	6.1	1.3	0.6	0.2	0.2	0.0
2001	53.4	172.5	34.9	8.4	2.3	0.3	0.5	0.2	0.3
2002	48.7	33.2	24.3	6.3	0.8	0.4	0.1	0.1	0.1

Table 9: Silver hake abundance and biomass estimates from ITQ survey, 1996-2003 for Scotian Shelf strata 440-483 (excludes Bay of Fundy).

year	#/tow	Wt/tow (kg)
1996	46.4	7
1997	43.1	6.3
1998	11.9	1.2
1999	64.8	7.6
2000	55.7	5.4
2001	29.4	4.5
2002	13.1	1.8
2003	55.9	2.6

Table 10: Predicted catch rates (tons/day) for silver hake in NAFO subarea 4W, in July, 1996-2003.

year	t/day
1996	6.83
1997	17.71
1998	10.90
1999	3.21
2000	4.70
2001	6.40
2002	6.02
2003	3.31

Table 11a: Mean length-at-age (cm) for male Scotian Shelf silver hake from July RV survey data.

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1		18.77	19.56	19.93	19.90	20.51	21.69	17.29	16.05	19.94
2		27.56	26.72	27.58	27.77	28.97	28.06	27.04	25.90	27.69
3		29.29	29.62	30.53	30.28	30.55	31.58	29.97	30.37	29.30
4		31.88	31.37	31.39	34.00	30.43	32.83	33.04	31.95	32.61
5		33.00	33.02	32.06	33.12		35.00		32.58	33.39
6			34.66	34.10		32.00	38.00	34.82	37.23	34.53
7			31.00	34.00	36.00				36.00	36.07
8										
9										40.00

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	16.96	18.02	17.17	18.27	19.60	18.90	18.00	18.32	16.41	18.40
2	25.98	27.24	26.90	25.49	26.99	27.12	27.19	25.29	26.41	25.72
3	29.94	29.33	30.56	30.18	28.76	29.85	29.33	29.09	28.45	28.16
4	31.07	31.11	31.13	31.82	30.97	30.61	30.75	30.83	30.37	29.64
5	32.76	32.34	33.34	33.02	32.20	31.61	31.97	31.24	31.17	31.63
6	33.79	33.98	34.00	34.3	34.03	33.01	33.01	32.91	31.63	32.54
7	34.51	39.06	35.76	36.69	35.88		34.09	39.77	32.71	34.76
8			35.06	40.00	36.11			37.32		33.00
9		38.00					33.00			

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	18.42	18.3	18.04	18.03	15.96	18.62	18.57	16.37	15.98	18.19
2	26.41	25.90	25.71	25.96	24.16	23.12	25.69	24.71	24.19	23.99
3	28.62	28.54	27.56	27.97	26.60	26.16	27.40	27.92	27.74	27.50
4	31.00	30.82	29.78	29.36	27.78	28.47	29.02	29.75	29.62	28.89
5	32.09	30.65	30.68	32.20	29.54	30.90	27.74	31.00	31.00	28.69
6		32.95	30.56		31.94	36.00	30.42		32.00	
7		35.00	33.11			33.00				
8										
9										

	2000	2001	2002
1	11.13	11.47	11.94
2	20.62	18.41	18.00
3	25.37	24.59	25.10
4	27.53	27.52	27.12
5	29.17	29.13	28.43
6	31.00	30.32	29.26
7		36.00	34.00
8			
9			

Table 11b: Mean length-at-age (cm) for female Scotian Shelf silver hake from July RV survey data.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1		18.89	20.36	19.82	20.49	20.54	21.23	17.65	17.26	18.97
2		28.59	27.99	28.84	28.75	30.40	29.90	27.97	26.29	28.85
3		31.54	32.99	32.90	33.05	33.73	35.09	33.10	31.97	31.71
4		33.72	35.24	35.85	37.24	34.76	37.10	36.50	35.49	35.34
5		36.51	36.32	38.56	42.20	40.81	39.81	39.79	37.78	38.76
6		47.00	45.61	41.58	45.82	45.50	47.94	42.15	40.40	44.49
7			42.48	46.31	51.31	53.42	47.12	50.59	48.71	47.63
8		45.00	56.29	51.02	56.76	54.98	50.35	47.15	51.81	55.03
9			50.00	57.00		61.00	52.33	57.24	52.82	53.25

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	17.23	17.56	17.18	18.34	19.79	19.81	18.11	18.51	16.66	18.75
2	26.35	27.50	28.82	26.60	28.05	27.98	28.01	26.07	27.36	27.00
3	31.92	31.37	32.76	31.62	30.17	31.50	30.76	30.82	30.38	29.99
4	33.85	33.99	34.75	34.74	33.19	33.46	33.16	33.08	32.11	31.32
5	38.53	37.24	36.03	37.80	36.09	34.96	34.80	35.64	34.05	33.81
6	42.83	40.99	37.80	41.13	38.60	37.75	36.62	38.60	37.43	38.18
7	45.61	44.61	45.46	44.37	41.66	41.46	41.53	42.48	40.10	40.06
8	45.34	46.63	50.61	45.52	46.52	47.39	45.04	46.41	43.54	43.78
9	51.62	54.32	50.64	51.26	48.97	51.14	47.72	48.10	49.18	52.68

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	18.62	18.67	18.24	17.59	16.63	18.99	17.98	17.32	16.52	17.49
2	27.38	26.85	26.47	26.35	24.63	24.09	26.47	25.61	25.09	25.58
3	29.56	30.16	29.57	29.07	28.22	27.69	29.17	29.70	29.72	29.10
4	32.37	32.80	31.49	30.97	30.10	30.45	30.23	32.61	31.02	31.49
5	34.82	34.66	33.18	34.13	32.00	33.37	31.71	35.40	33.58	33.35
6	37.84	36.13	34.61	36.01	37.84	36.88	37.74	36.91	37.72	37.42
7	40.01	40.67	40.16	36.75	40.47	40.43	40.02	51.78	38.15	37.89
8	43.60	49.20	46.75	38.44	43.73	43.77	44.97	53.15		45.00
9	41.64	44.59	46.28	45.00	43.67	47.16	51.44	46.00		46.00

	2000	2001	2002
1			
2	20.82	17.92	18.16
3	26.88	25.52	26.36
4	29.52	29.70	28.28
5	31.50	31.88	31.05
6	37.08	33.86	33.02
7	39.94	37.92	34.56
8	37.83	44.14	41.92
9	41.66	45.51	45.09

Table 12a: Mean weight-at-age (g) for male Scotian Shelf silver hake from July RV survey data.

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1		52.5	52.6	42.5	44.9	70.8	75.4	21.8	3.6	45.7
2		153.7	135.5	154.3	147.1	189.6	161.3	155.4	127.5	159.0
3		175.2	178.9	202.9	182.7	217.1	209.4	209.3	211.7	192.6
4		183.2	218.6	236.9	300.0	206.6	239.6	279.2	245.6	238.3
5		325.0	244.2	245.4	222.1		250.0		258.2	280.7
6			280.5	303.8		225.0	275.0	323.6	377.0	311.0
7			225.0	250.0	400.0				300.0	351.7

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	3.6	24.0	14.2	18.9	41.9	36.4	14.7	24.4	9.7	16.6
2	120.2	147.8	137.8	106.9	137.0	132.6	132.3	110.3	130.8	113.0
3	199.1	186.1	215.9	171.8	160.2	178.9	168.7	174.7	166.7	146.6
4	225.0	228.6	235.9	216.7	211.9	184.7	202.9	197.7	189.2	160.0
5	260.5	263.6	275.3	262.5	228.0	224.0	233.0	223.6	252.9	222.6
6	285.2	306.8	291.1	272.2	267.4	282.8	258.7	249.4	235.5	227.0
7	274.3	409.5	315.8	326.9	269.5		253.9	469.1	241.5	288.9

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	30.5	27.0	37.3	39.4	24.9	38.8	43.2	28.2	23.8	41.4
2	129.9	119.3	123.3	116.0	89.8	84.2	114.5	100.1	94.8	93.2
3	155.4	161.5	149.3	133.9	120.7	124.0	132.5	150.1	138.3	135.9
4	219.4	201.7	198.5	174.7	139.0	165.9	165.5	206.7	181.1	160.5
5	251.1	214.7	238.6	214.2	173.5	194.1	148.4	205.9	200.0	160.6
6		266.7	218.3		200.9	340.0	226.6		218.0	
7		275.0	241.1			235.0				

	2000	2001	2002
1	56.0	38.7	37.4
2	101.1	99.2	104.8
3	132.5	136.8	132.5
4	166.8	159.5	154.1
5	180.0	141.1	176.0
6		310.0	296.0
7			

Table 12b: Mean weight-at-age (g) for female Scotian Shelf silver hake from July RV survey data.

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1		52.2	55.8	40.2	43.0	67.1	67.3	24.2	9.5	38.7
2		181.1	163.1	173.1	166.6	219.7	203.6	172.8	130.2	173.5
3		228.1	271.1	256.3	267.1	301.9	308.5	289.2	253.3	239.4
4		299.3	334.4	340.8	388.3	363.5	367.3	387.1	350.3	303.0
5		386.2	371.0	428.9	579.8	575.3	493.6	488.5	424.2	449.0
6		925.0	789.6	557.9	713.5	768.6	973.6	639.6	526.7	683.2
7			609.5	810.8	1169.4	1238.9	784.6	1173.9	971.8	786.7

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	4.0	19.3	15.4	22.5	42.2	44.3	12.7	27.4	7.1	32.4
2	124.6	159.9	174.7	125.6	156.1	149.8	148.6	118.4	150.0	126.0
3	246.9	241.3	248.4	215.7	205.4	214.3	199.1	207.1	208.1	157.3
4	285.9	300.2	319.9	283.0	262.8	256.7	253.2	264.5	241.5	177.2
5	453.8	404.4	361.7	387.0	327.1	311.1	300.9	340.9	302.8	274.5
6	659.8	548.9	431.0	514.3	426.2	408.9	372.1	432.6	396.2	432.4
7	793.3	691.8	796.9	717.7	562.7	524.3	550.0	624.8	503.6	549.2

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	33.3	34.3	41.3	32.5	27.8	45.2	36.5	34.4	27.1	32.7
2	141.8	135.1	131.7	121.2	96.6	96.0	129.1	117.0	107.1	112.8
3	179.7	207.5	196.3	162.0	149.3	146.0	173.1	183.0	183.2	165.1
4	228.3	250.8	242.8	209.4	183.1	201.4	191.8	271.5	213.9	224.4
5	323.2	301.2	294.5	271.5	228.8	275.1	218.9	335.2	274.7	267.8
6	415.2	355.3	374.8	335.2	403.6	374.7	446.0	427.5	440.1	380.7
7	523.3	500.5	633.6	337.3	563.7	545.7	484.7	1296.8	417.6	420.3

	2000	2001	2002
1	57.4	34.7	38.4
2	127.5	109.2	122.6
3	175.0	174.5	148.8
4	213.1	231.4	206.7
5	378.0	298.3	251.4
6	490.1	441.2	297.3
7	400.2	798.7	543.9

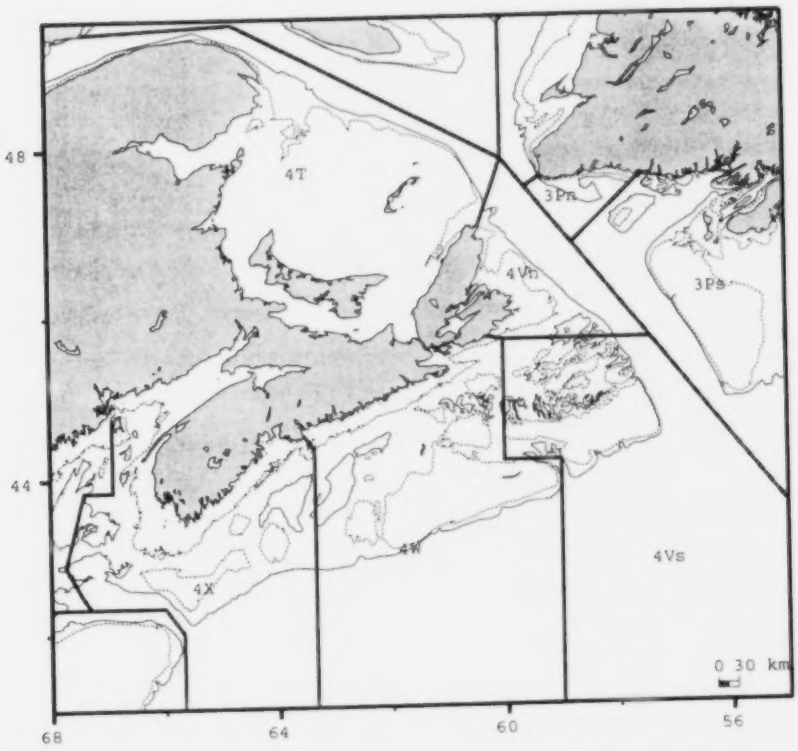


Fig 1: North Atlantic Fisheries Organization statistical areas: Divisions within Subarea 4.

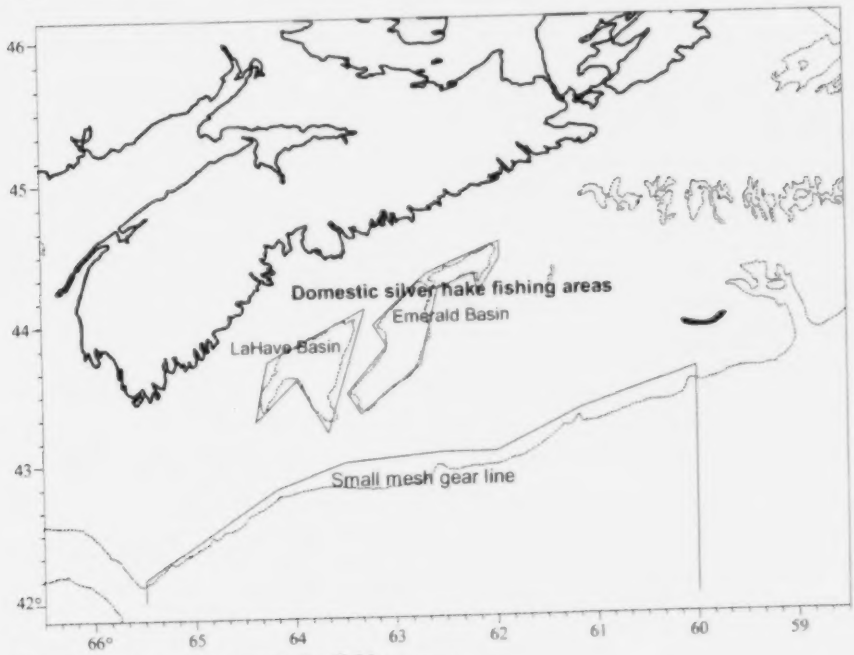


Fig. 2: Scotian Shelf silver hake fishing areas.

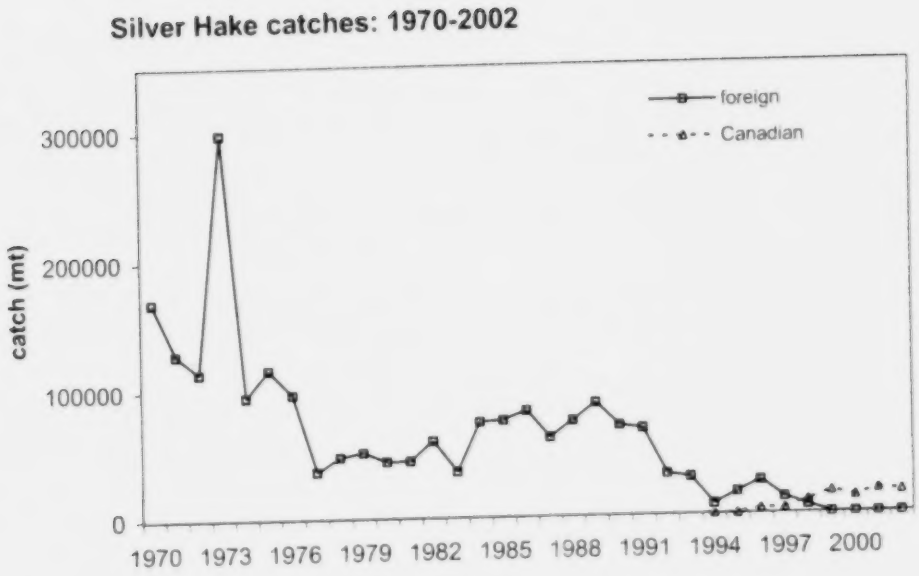


Fig. 3: Historical catches of Scotian Shelf silver hake.

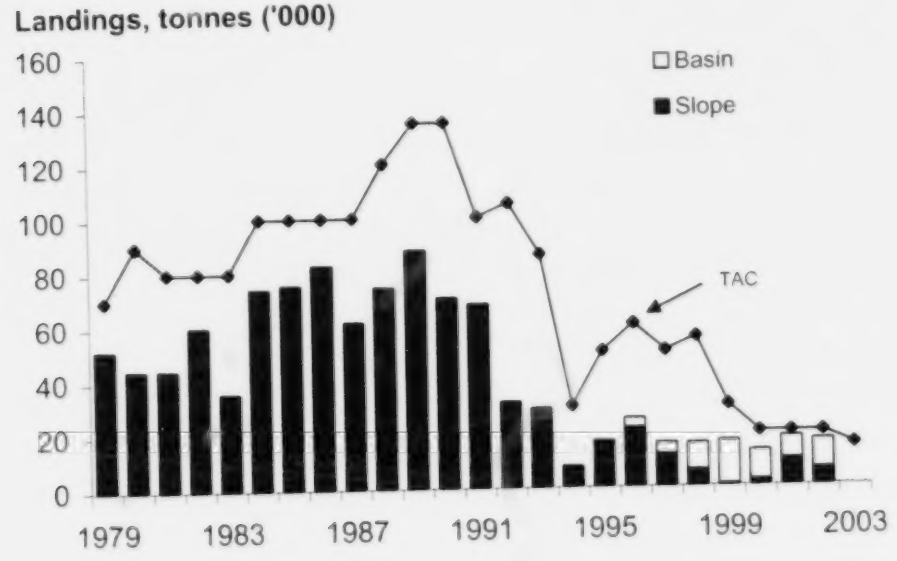


Fig. 4: Silver hake TAC and catches by fishing area, 1979-2003.

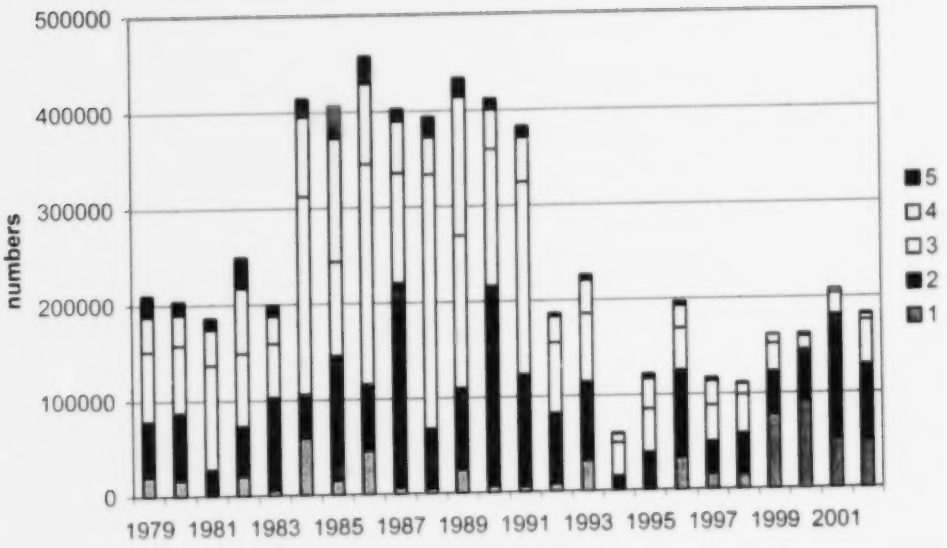


Fig. 5: Silver hake catch at age comparison for all fleets, ages 1-5 from 1979 to 2002.

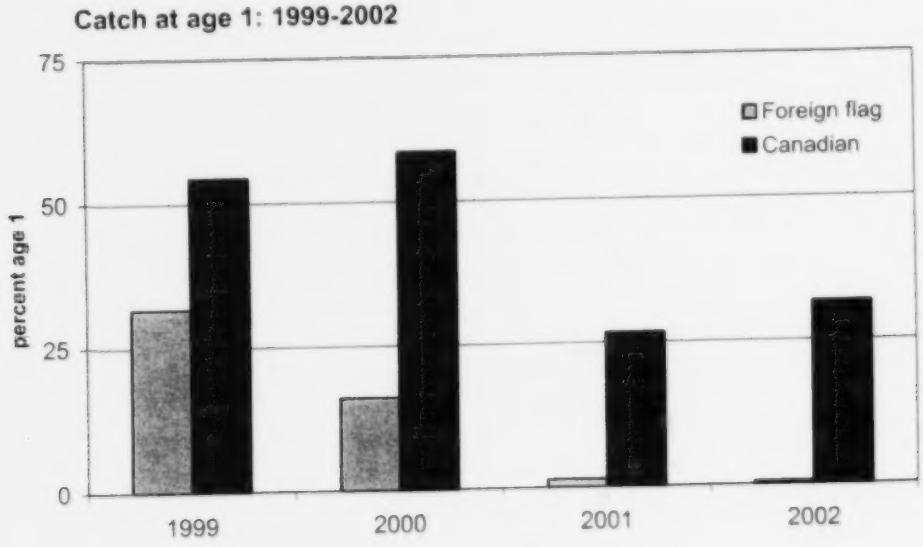


Fig. 6: Silver hake age 1 catch by fleet, 1999 to 2002.

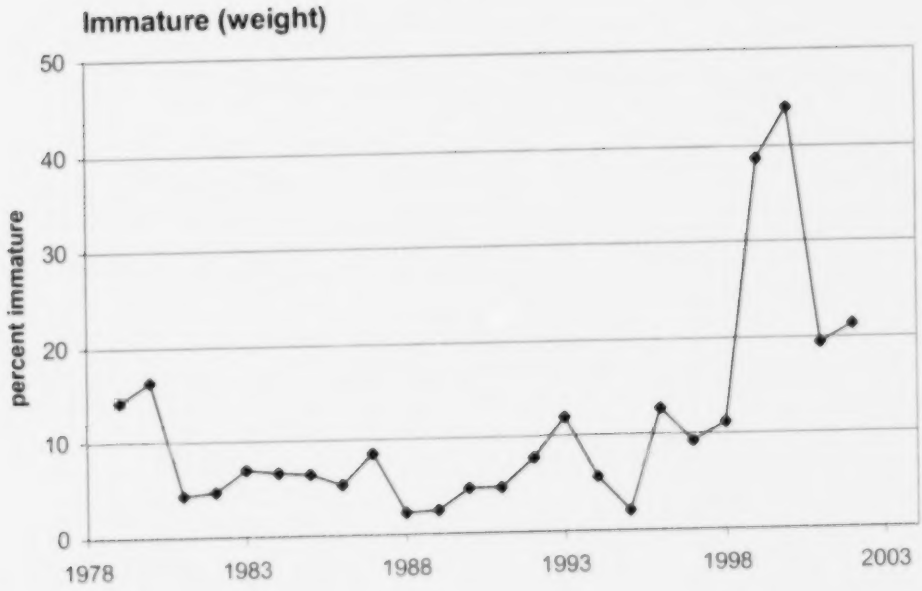


Fig. 7: Percentage immature catch of silver hake by weight in the commercial catch of silver hake for all fleets, 1979 to 2002.

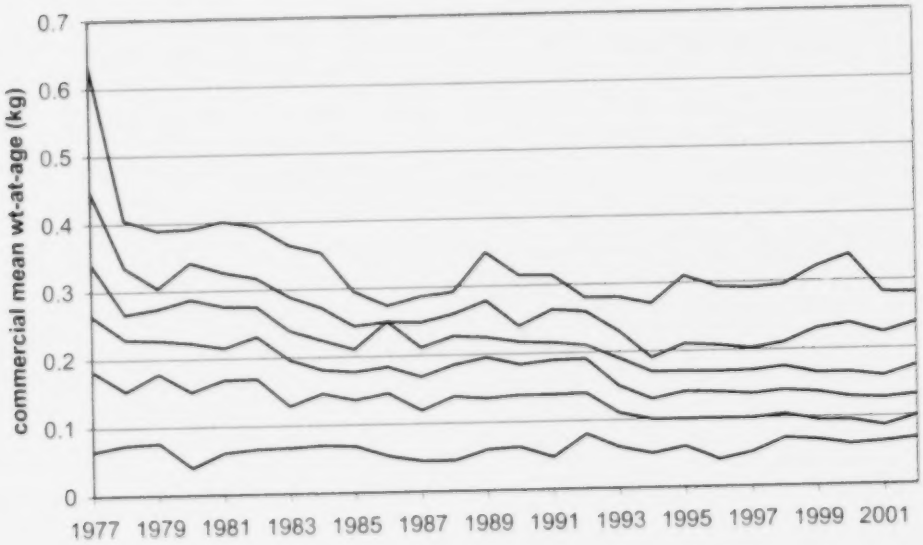


Fig. 8: Commercial mean weight-at-age for Scotian Shelf silver hake, age 1-6.

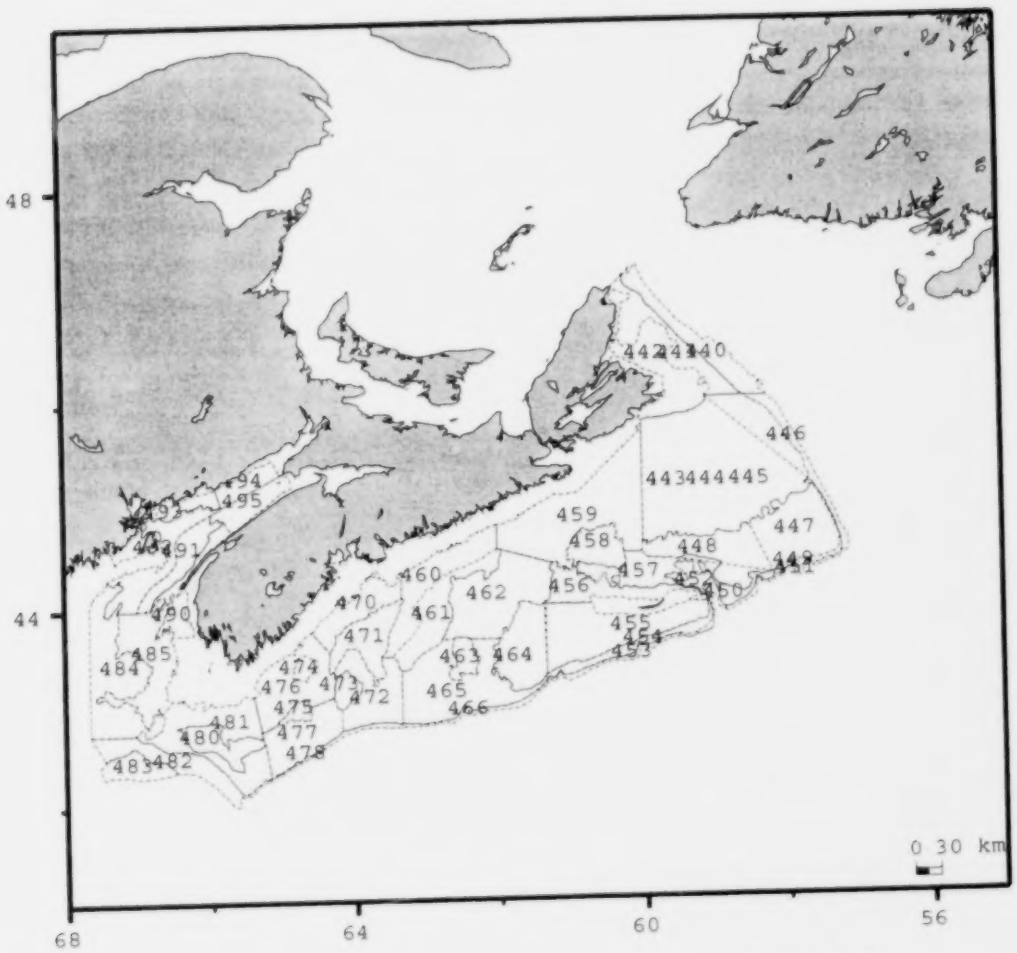


Fig. 9: Stratification scheme for the DFO Summer groundfish survey on the Scotian Shelf.

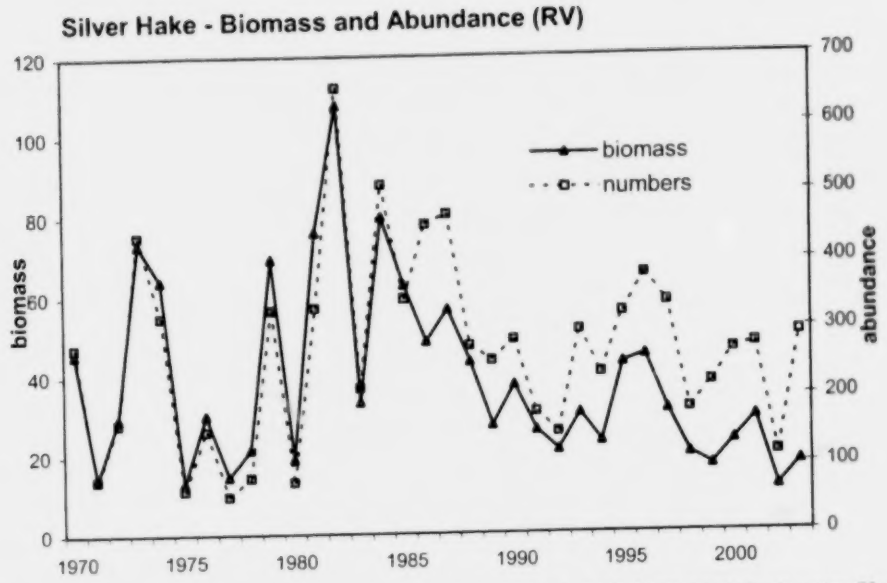


Fig. 10: Silver hake abundance and biomass estimates from July RV, 1970-2003 for Scotian Shelf strata 440-483 (excludes bay of Fundy). Years 1970-81 corrected for survey vessel effect.

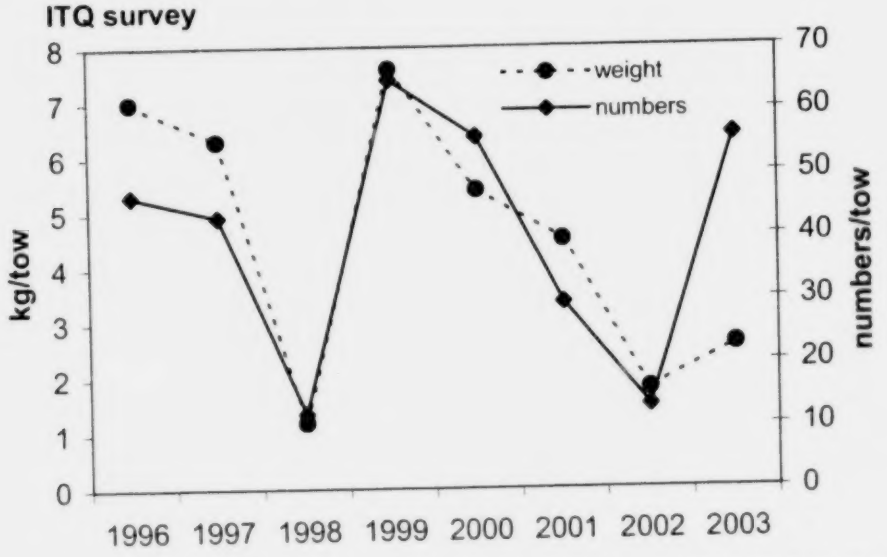


Fig. 11: Silver hake abundance and biomass estimates from ITQ survey, 1996-2003 for Scotian Shelf strata 440-483 (excludes Bay of Fundy).

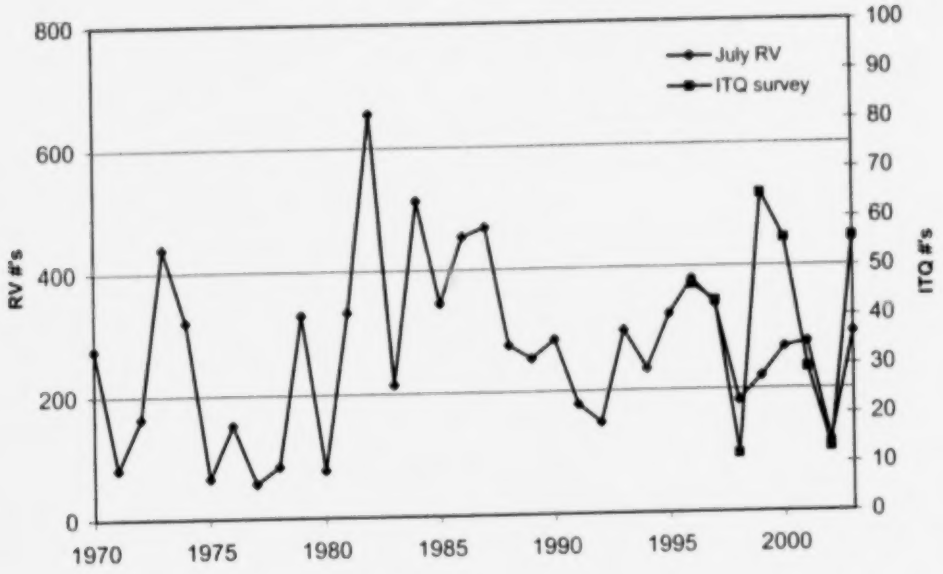


Fig. 12: Comparison of July RV survey number to ITQ numbers per tow (Strata 484 to 495 excluded).

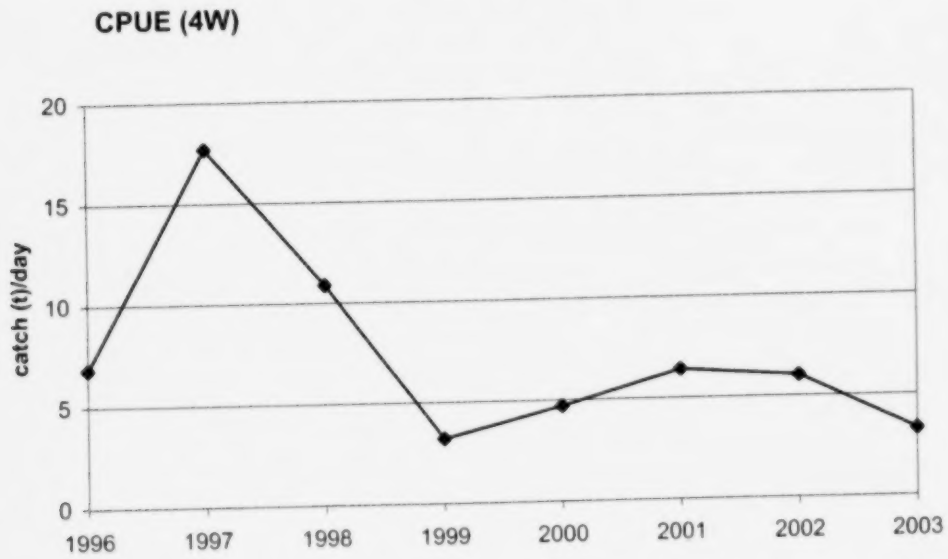


Fig 13: Predicted catch rates (tons/day) for silver hake in NAFO subarea 4W, in July, 1996-2003.

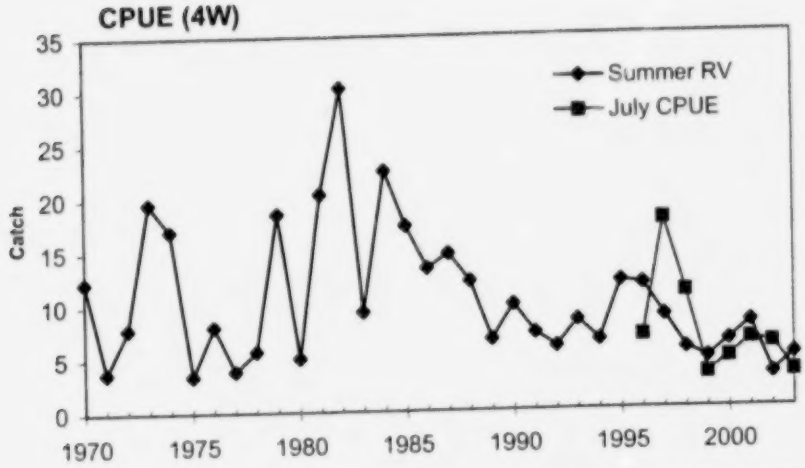


Fig 14: Comparison of July RV survey kg/tow in 4W with standardized July commercial CPUE (t/day) in 4W.

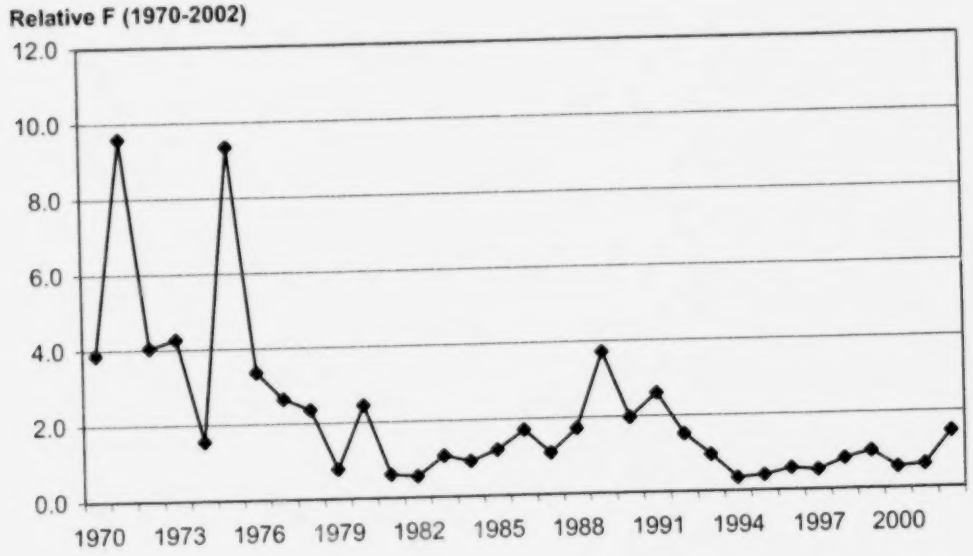


Fig 15: Relative F for Scotian Shelf silver hake from July RV biomass and commercial catch weight.

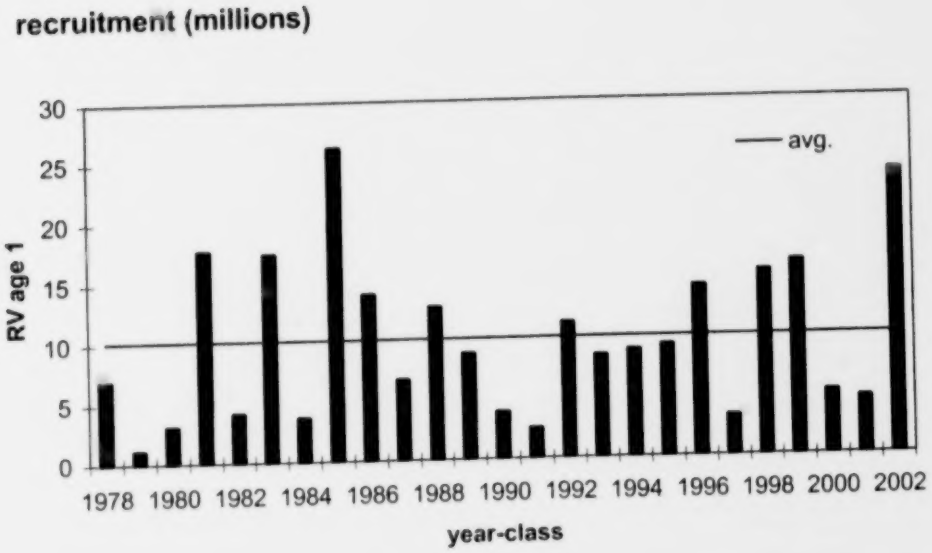


Fig 16: Recruitment estimates for Scotian Shelf silver hake from age 1 July RV survey abundance (2003 point estimated from length data).

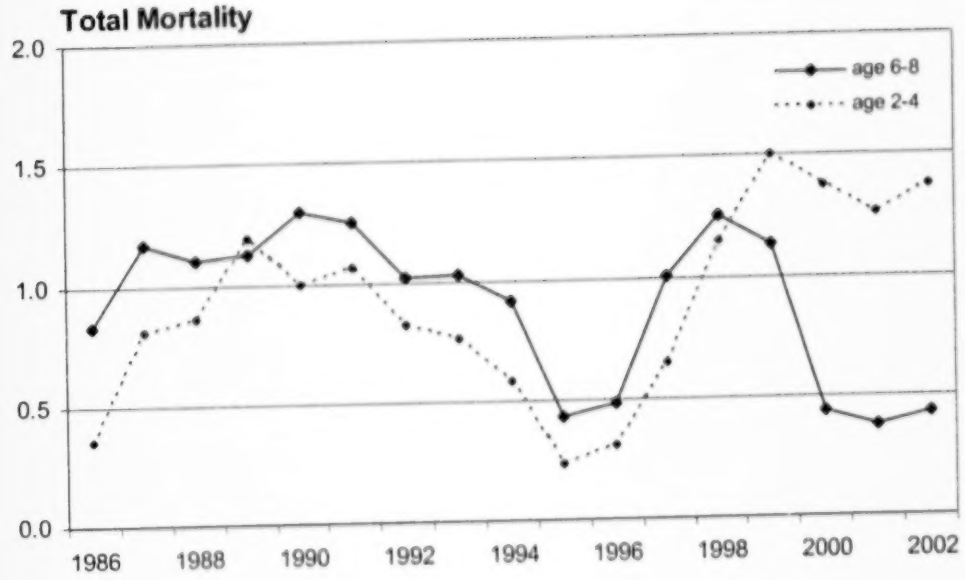


Fig 17: Smoothed estimates of total mortality for Scotian Shelf silver hake from July RV abundance.

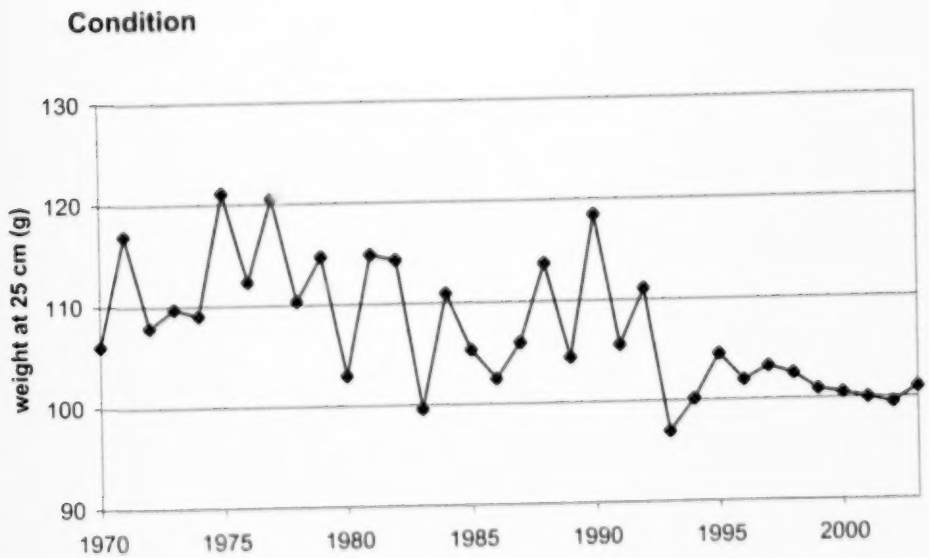


Fig 18: Condition factor (predicted weight at 25 cm) for Scotian Shelf silver hake from July RV survey data.

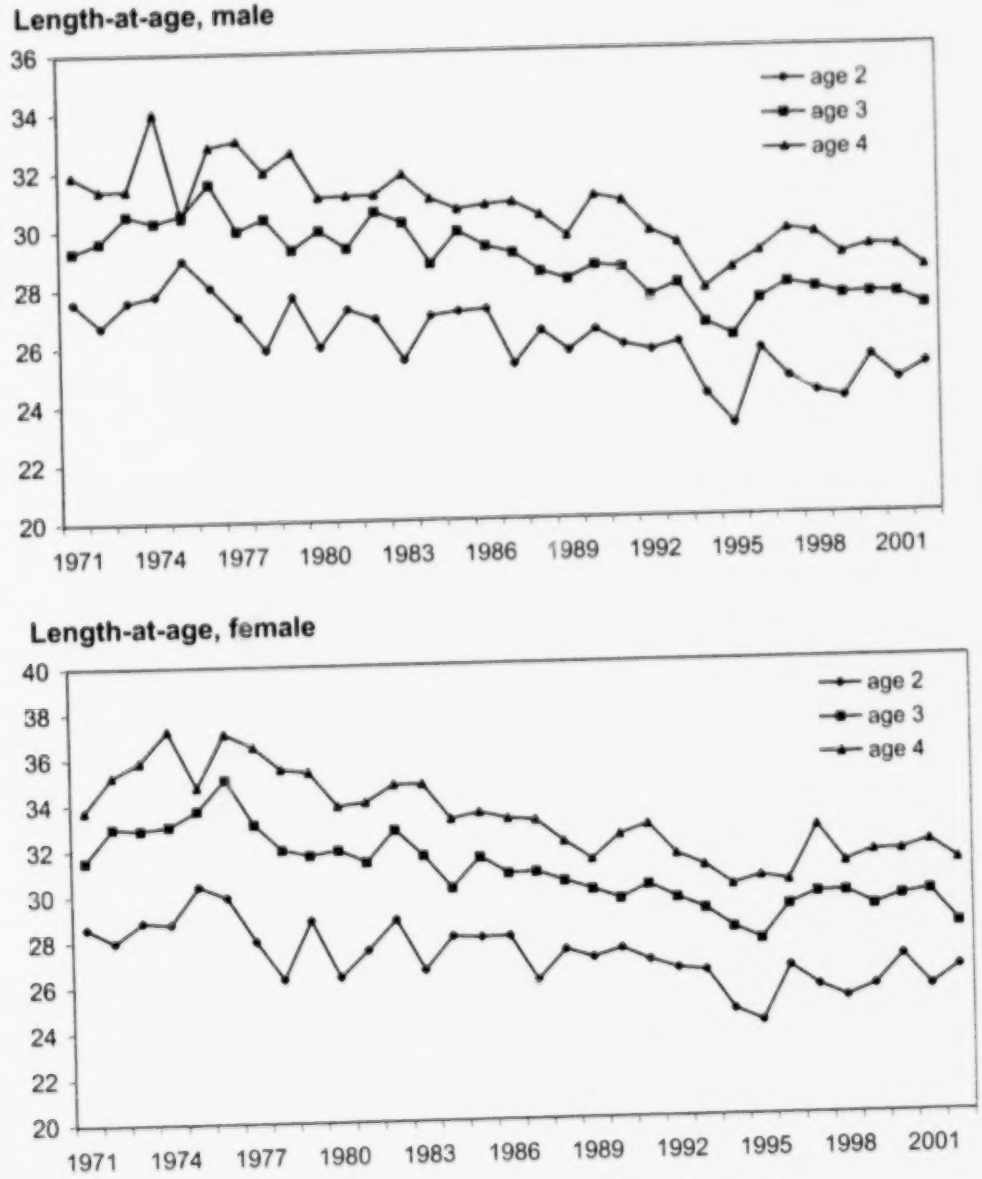
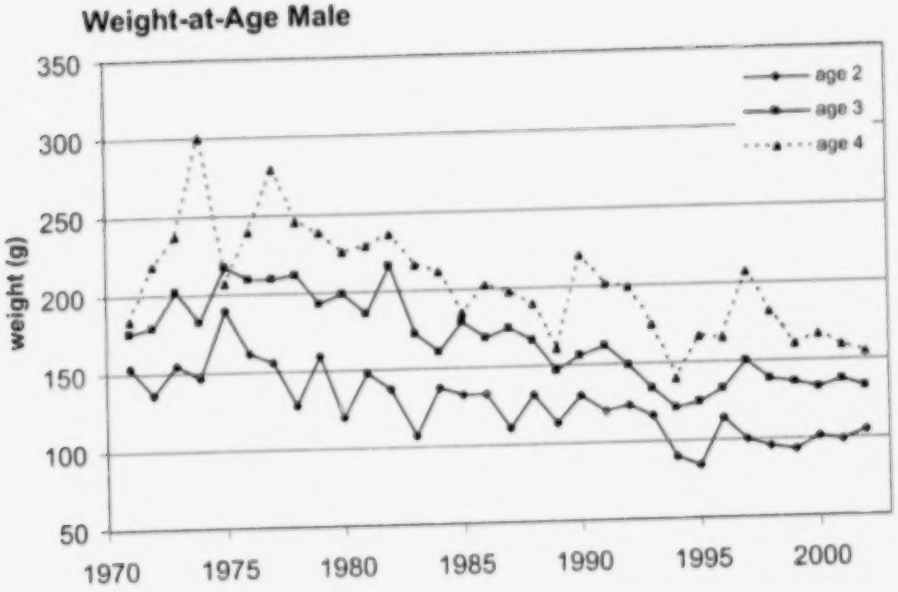


Fig 19: Mean length-at-age for Scotian Shelf silver hake from July RV survey data.



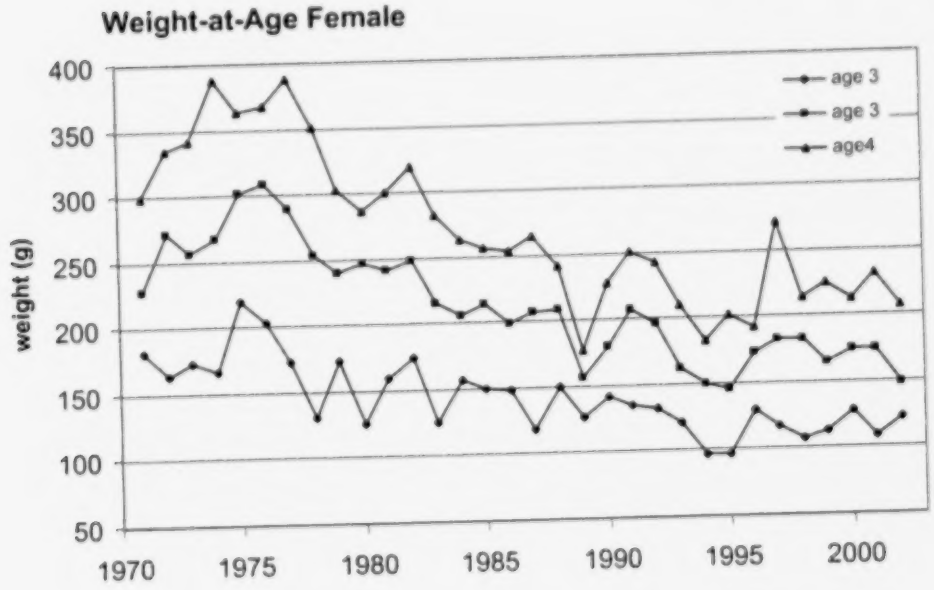


Fig 20: Mean weight-at-age for Scotian Shelf silver hake from July RV survey data.

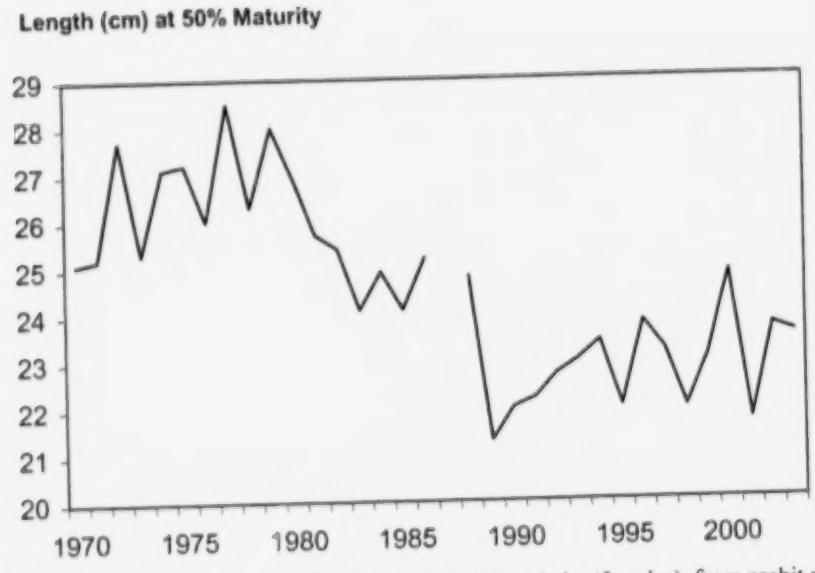


Fig 21: Length of 50% maturity for Scotian Shelf silver hake (females), from probit analysis of July RV survey maturity observations, 1970-2003 (no data in 1987).

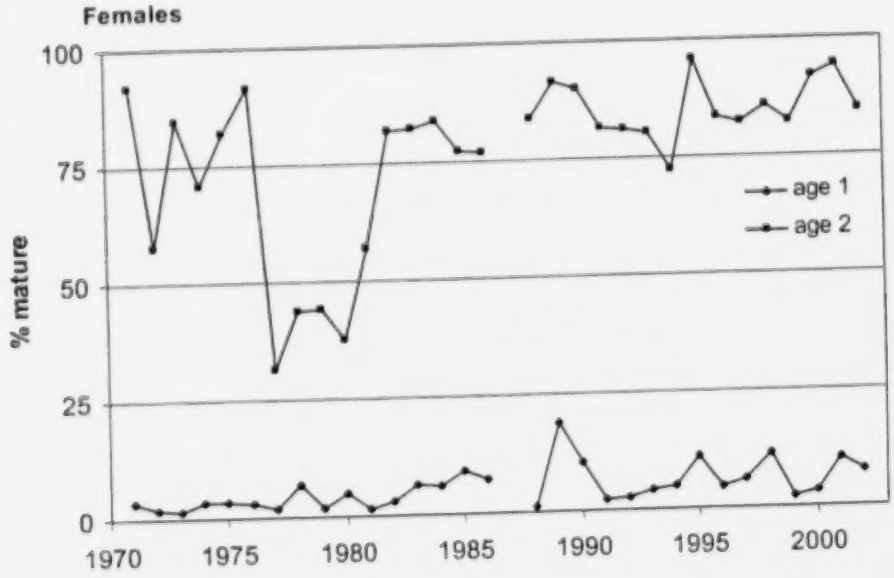


Fig 22: Proportion mature at age for female Scotian Shelf silver hake, 1971-2002.

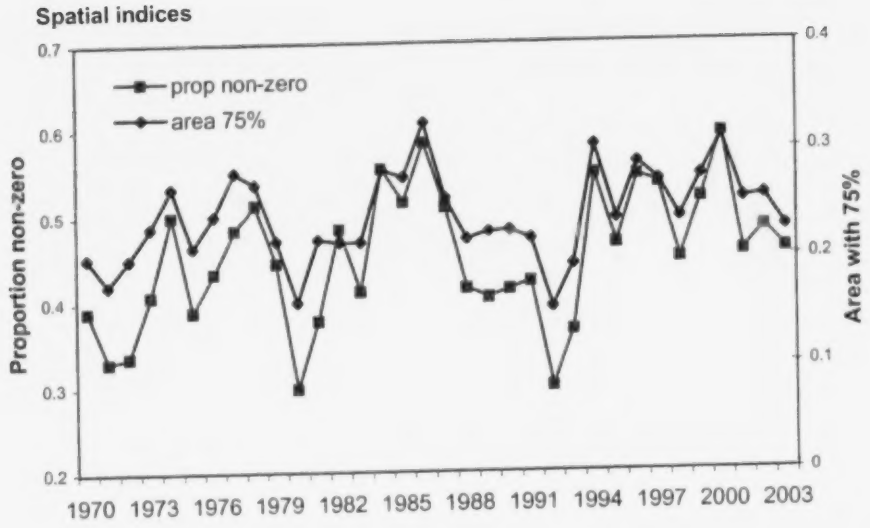


Fig 23: Indices of spatial distribution Scotian Shelf silver hake from July RV survey, 1971-2003.